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A Design of Mine WSN Layout Strategy

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Abstract

Wireless sensor networks is a kind of brand-new information acquisition and processing technology, combined with sensing, computation and communication technology, and have great advantages using coal production. Firstly, a ribbon WSN's network layout model is raised in this paper, and it based on the characteristics of mine roadway type. Then uses the NS to simulate the having proposed WSN network topology. At last, the paper analyzed the data packet during the process of simulation to estimate the WSN work performance about throughput and delay. This design can guide the set WSN node's parameter, increase network's quality and manual network's layout.

Keywords：Wireless Sensor Networks，WSN, mine communication, NS2,Network simulation;

1. Introduction

Mine underground working environment is complex [1], and disasters are easy to break out. To improve the efficiency and realize self-help, reliable and secure communication is greatly necessary. Because of mine condition and communication equipment constraints, traditional mine communication system is difficult to achieve dynamic, comprehensive monitoring and analysis. To overcome these shortcomings, a WSN applied scheme is proposed. As a new kind technology, the WSN applied communication system is an intelligent network system that can realize data collection, integration and transmission. The mine wireless network system is meaningful in personnel orientation and disaster communication.

The WSN network of the mine is complex and is constrained by the economic conditions because of the bad environment. Before applying to the mine communication, the WSN will be tested, evaluated and validated. There are many constraints in the effectiveness and accuracy of mathematical analysis. Though the test method can obtain more realistic results, limitations exist. The test methods are costly, heavy workload and difficult to reconfigure or share resources, and inflexible in using. Network simulation [2] can achieve the network performance analysis in a complex environment at low cost, it can

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reproduce the real network environment through modify some certain parameters. This paper analyzes the simulation of the WSN environment in the limited space mine communications network at first, and then analyzes network data throughput and delay aspects according to the network environment features, thus optimize the network performance while it applied.

2. Disadvantages of traditional Mine communication network

Roadway is a kind of non-uniform spatial heterogeneity of the border, it is distributed complexly. Here are many disadvantages in cable communication, and constraints also exist in wireless communication [3].Although cable communication is reliable and the capacity of data transmission is great, but the wiring is complex, labor intensity is high. The network structure is relatively fixed; it isn't suitable for extended dynamic tunneling face requirements. Monitoring sites are relatively fixed, blind spot monitoring is easy to appear. Communication line is easy to be destroyed, and it can recover after a long time. The maintenance cost of the communication lines is high.

Underground mine wireless communication belongs to non-free space communication technology. Because of the complex roadway distribution, the transmissions of electromagnetic waves are almost cut by half. If the density of the wireless node distribution is intensive, it will cost a lot in network maintenance and management. Many underground wireless technologies are moving from theory to practice.

3. Mine WSN Model

This paper proposes a kind of communication mixing wired with wireless (Fig 1). WSN nodes transmit data to the base station and gateway through a single hop and multi hops, and then transmit them to the host computers. Inoue staffs process the collected data and make judgments on the underground environment, then send instructions to the WSN.

The information transmission space is roadway in secure channel, transport channel and coal face. In this environment, WSN network is distributed in zonal. The wireless nodes are generally fixed on both sides of the tunnel wall. If the wireless nodes are distributed in single line way, the network is unstable because of the signal absorption, reflection and refraction. In the distributed way of arranging uniform on both sides (Fig 2), the transmission will be more reliable and the network will be more stable. Nodes collect and send data normally. While equipments and persons' nodes moving in the net, WSN network will send the mobile nodes' information.

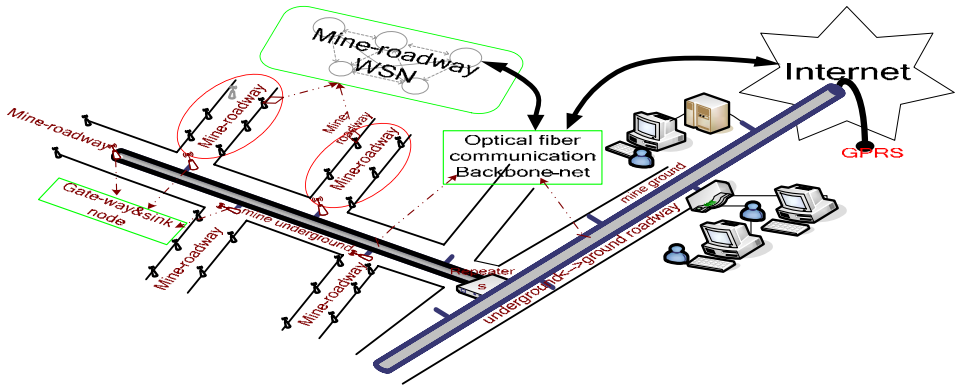

Fig 1 Mine communication system model

4. Network model simulation

NS-2[4] not only can test the network performance and features, but also can predict the designed network performance, thus can optimize the net at the most extent. Its main functions are: make the net abstract, identify its topology model, use Otcl[5] language and class library to describe the network, compile and simulate the source code to obtain simulation results.

4.1. Process Design

To simulate the new algorithm protocol, design the source code by C++ firstly, then modify the relevant documents in NS-2, finally write the TCL [5] code. To test the network performance and optimization, just need to write the TCL code and modify the related parameters. TCL code is the mainly network code and business agent model. The simulate process show as figure 3.

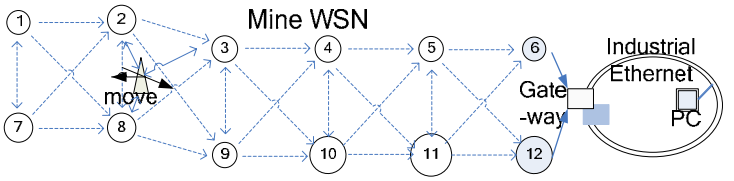

Fig 2.Mine tunnel WSN network layout model

4.2. The net code

4.2.1. Network Code

The underground WSN network can be arranged in artificial by the network model. So the location of wireless nodes will affect the overall network performance. Following are network nodes location setting codes. set num 4 ;#setting number of node

for {set i 0} {$i < $num} {incr i} {$node_($i) set position_ [expr function] };# setting node's position, position is X,Y,Z coordinate, function=f(X,Y,Z,i) }

To set the mobile nodes, fixed location can be set, mobile command can be set by setdest command, moving in a fixed area also can be set. make node_(0) moving in the rate of 5.0 from 0.0 to 500.0 in the X-axis. $ns_ at 0.5 "$node_(0) setdest 0.0 500.0 5.0",

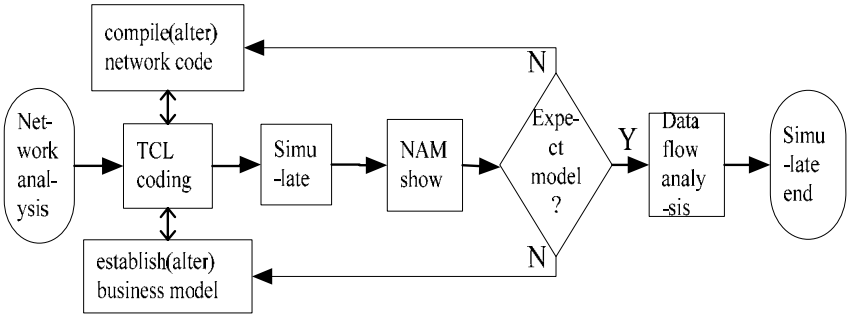

Fig 2 The topology of the network simulation process of NS - 2

4.2.2. Business Model

Network simulation is to analyze the network performance through the sending and receiving business of the simulation process. To analyze and change the parameters of the business performance in the network, codes in the data flow generated by the simulation process should be easy to be modified.

```
set agent1 [new Agent/UDP]                ;#setting new agent.
$agent1 set prio_ 0                       ;# set priorities
$ns_ attach-agent $node_(0) $agent1       ;# connect source node and source agent
set sink1 [new Agent/LossMonitor]         ;# set destination agent
$ns_ attach-agent $node_(1) $sink1        ;# connect  end node and receive agent
$ns_ connect $agent1 $sink1               ;#connect   source agent and receive agent
set app1 [new Application/Traffic/CBR]    ;# setting new traffic
$app1 set packetSize_ 512                 ;# setting the size of packets
$app1 set rate_ 256Kb                     ;# setting the data's rates
$app1 attach-agent $agent1                ;#connect the agent and packets
```

5. Simulation Analysis

To prepare TCL in the ns-2.33 software, the TwoRayGround channel model, wireless physical layer network interface, FIFO queue mechanism and DSDV routing protocols are selected. Arrange the simulation WSN nodes in a 10×100 band-shaped region. The node's signal threshold is 1.559×10^{-10}, the transmission distance is 100m, the corresponding transmission power is 3.08×10^{-4}. A mobile node in the middle of the network sends and receives mobile data, the simulation time is 100 seconds. After the simulation, .nam files and .tr files will produce. Run the nam command, NAM will display and AWK[6] language will analyze the tr file.

5.1. NAM Display

NAM[7] file will run after the simulation through the "exec nam file-name.nam &" command. The NAM file can show the data stream send and receive in the simulation process. Fig 3 is the screenshots of the simulation at the beginning and after a period of time.

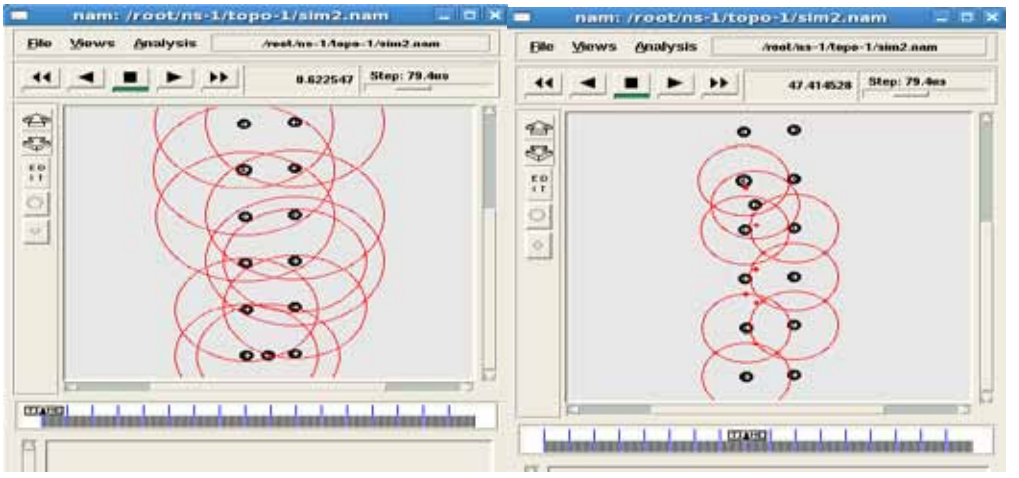

Fig 3 simulation interface

5.2. Data Analysis

Through the awk command, tr file will be analyzed. This paper analyzes the mine WSN throughput and data delay performance through the comparison of mobile nodes emission rate of 256kb, 512kb and 1024kb.

5.2.1. Throughput

Throughput is the amount of data in the condition of no packet losing in the unit time, it is effected by the network performance. More packets, more throughput and better the network performance. Fig 4 is the simulation analysis results.

Through the fig 4, we can see that when the transmission rate are 256KB and 512KB, with the mobile nodes sending rate increases, the amount of the destination nodes and throughout increases. And when the transmission rate is 1024KB, the amount of received packets reduces, it is due to the net congestion and packets loss and queue delay.

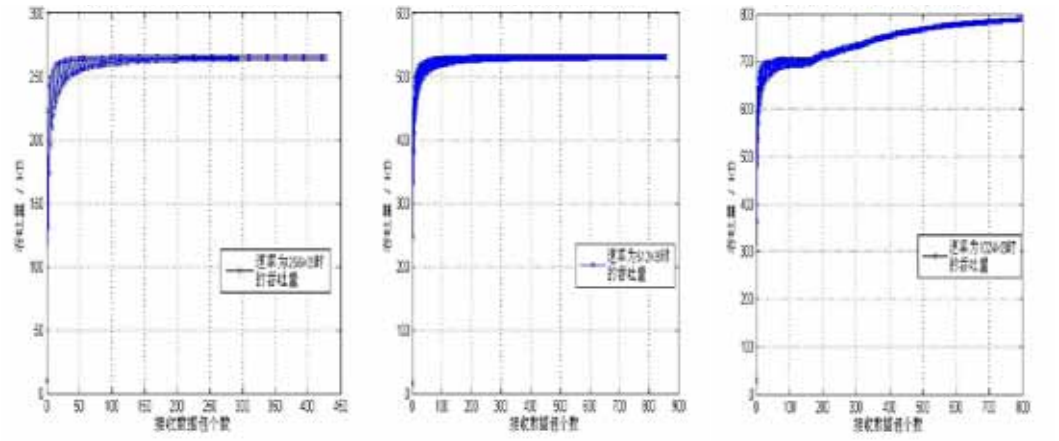

Fig 4 the number of throughput and receive bag relationship chart when rate is 256kb(first picture), 512kb(first picture),1024kb(first picture)

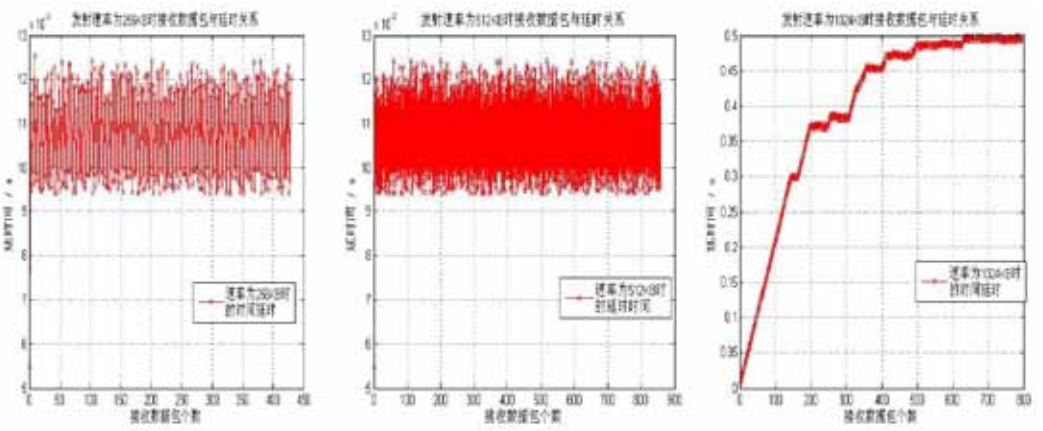

Fig 5 delay and receive number of packets when rate is 256kb(first picture), 512kb(first picture),1024kb(first picture)

5.2.2. Network Delay

Network Delay is an important network performance to the data has high requirements of real-time. Through packet transmission and arrival time, this paper calculates the transmission delay. The net will be more stable if the delay is less. Fig 5 is the simulation result.

From the Fig 5, we can see that when the transmission rates are 256KB and 512KB, with the mobile nodes sending rate increase, and the packet delay almost constant. When the transmission rate is 1024KB, because of the net congestion, the amount of receive packets reduces, the packet delay increases.

5.3. Analysis of simulation results

By comparison, we can see that when the transmission rate of the sending nodes is less than 512KB, the transmission rate increases, the destination nodes receive more data packets, the packet delay almost constant and the throughout increases. When the sending nodes rate is more than 512KB, the number of received data packets of the destination nodes is up to 800, the throughput and the packet delay increase. The appropriate transmission rate can increase the throughput and reduce the packet delay.

6. Conclusion

In this paper, a scheme is proposed according to the characteristics of the mine tunnel. A ribbon WSN is applied in the underground. The topology of the network was simulated by NS-2. We did a research on the node positions and node properties, analyzed the effects of transmission rate to the throughput and packet delay. Faster the transition rate, better the network performance is not right in this research, appropriate transmission rate can improve the network performance. It is meaningful to the artificial arrangement of the underground network.

Acknowledgements

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References

[1] Xingpeng JING,Weifeng WANG and Lianping CHEN.Mine safety wireless monitoring systems research coal. COAL ENGINEERING. No.2,2010

[2] Ping WU, Lei SUN and Kaiyong XU. Based on the NS - 2 Ad Hoc network distributed CA simulation COMPUTER ENGINEERING Vol.34,No.16,Aug 2008.

[3] Jiping SUN, Mobile communication and the status of mine key scientific and technological problems. Industry and Mine Automation. No.7,July 2009

[4] Huaji HUANG, Huili FENG and Lijiao. QIN. NS network simulation and protocol emulation. BEIJING: POSTS & TELECOM PRESS May 2010.

[5] Wei LOU Juan LOU and Bing PENG, Based on the NS - 2 wireless network simulation analysis and research,Computer Knowledge and Technology.Vol.5,No.10,April 2009,pp.2576-2578.

[6] Qiuna NIU, Meiqin WANG and Yinglong WANG. Based on the NS - 2 MANET routing protocol emulation and performance evaluation. Application Research of Computers.

[7] Xiaowen KOU, Tie JUN. NS network simulation technology and its output and analysis. INFORMATION TECHNOLOGY. No.12, 2007